Phase Change Materials by Design: Taming Bond No. 6

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Abstract

Phase change media utilize a remarkable property portfolio including the ability to rapidly switch between the amorphous and crystalline state, which differ significantly in their properties. This material combination makes them very attractive for data storage applications in rewriteable optical data storage, where the pronounced difference of optical properties between the amorphous and crystalline state is used. This unconventional class of materials is also the basis of a storage concept to replace flash memory. This talk will discuss the unique material properties, which characterize phase change materials. In particular, it will be shown that only a rather small group of materials utilizes a unique bonding mechanism ('Bond No. 6'), which can explain many of the characteristic features of crystalline phase change materials. Different pieces of evidence for the existence of this novel bond will be presented. This insight is subsequently employed to predict systematic property trends and to explore the limits in stoichiometry for such memory applications. It will also be demonstrated how this concept can be used to tailor the electrical and thermal conductivity of phase change materials. Yet, the discoveries presented here also force us to revisit the concept of chemical bonds and bring back a history of vivid scientific disputes about 'the nature of the chemical bond'. Finally, we will employ these concepts to identify property trends for chalcogenide glasses.

Keywords: chalocgenide glasses, phase change materials, electronic memory, fast crystallization

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